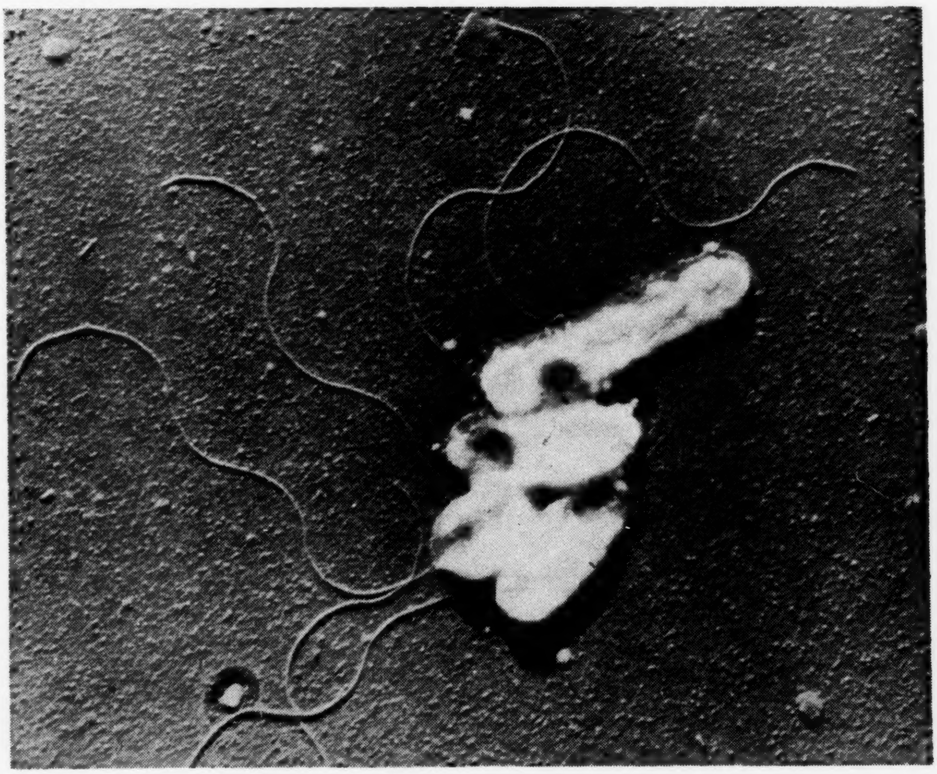
MAIN CURRENTS

IN MODERN THOUGHT



For description of this illustration, see table of contents.

VOL. 10 NO. 5

MAIN CURRENTS IN MODERN THOUGHT

A co-operative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.

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The photograph on the cover, illustrating the article on Scientific Photography, page 104, shows the bacteria (Pseudomonas fluorescens) as it appears through the electron microscope when magnified 20,000 times. These cells are seen as small motile bodies when examined with the regular microscope, and the flagella that show so clearly under the increased resolution of the electron microscope are not visible unless they are coated with extraneous material.

— Ruth Lofgren, University of Michigan

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The corporate statement of Aims declares that the Foundation has been established:

1. To collect, create, and distribute authoritative materials which will encourage the development of unified overall concepts in education; to improve the balance of relationships between the physical sciences and the social sciences; to inquire into the phenomena of purposive activity in nature, man and the universe.

2. To assist teachers to understand and use such materials, and to develop an active, realistic, comprehensive philosophy which will communicate to their students the unity, coherence, and beauty of the world in which we live.

3. To remedy, solely by such educative measures, the conceptual and hence the ethical, social, economic, and political breakdown of our times, looking to a peaceful world order.

The members, associates, and staff of the Foundation realize that the progressive discovery of unifying over-all concepts concerning man and the universe is not a task to be performed successfully in isolation from the historical, social, economic, and political context of our times, nor in terms of application less than global.

The work of the Foundation is wholly educational, yet is referred constantly to the contemporary scene in all its aspects, no less than to the total available wealth of human experience and knowledge.

MAIN CURRENTS IN MODERN THOUGHT is published 5 times a year in Sept., Nov., Jan., March, and May, to call attention to significant contributions to learning currently being made by workers in the multiple fields into which knowledge has come to be classified. It relates these advances to each other and to the classical and contemporary views of Eastern, European and American thinkers. It is designed to save time for the reader by providing a vantage-ground from which the whole world of knowledge may be surveyed and kept in proportion as it moves toward integration. Its editors assume that the principles of art, the universals of philosophy, the laws of Nature and Man as formulated by science, and the truths of comparative religion, can be orchestrated into a harmonic, meaningful, ethical body of teachings which can and should be made the central core of curricular study in the educative process at all levels of development. In condensing text, square brackets [ ] indicate editorial interpolation. Three dots . . . in the text indicates a word, phrase or passage omitted in the interest of brevity or clarity. Other usages are standard. $3.00 a year. Foreign $3.50. Contributors to MAIN CURRENTS enjoy full liberty of opinion and expression in these pages. *to whom all communications regarding MAIN CURRENTS IN MODERN THOUGHT should be addressed. Entered as second class matter April 13th, 1946, at the post office at Port Chester, New York, under the Act of March 3rd, 1879. (Reentered as second class matter November 17th, 1953, at the post office at Port Chester, New York, under the Act of March 3rd, 1879.)*

THE LOGICAL STRUCTURE OF PHYSICS AS A DEDUCTIVE SCIENCE*

Robert B. Lindsay

Brown University

Why should we discuss physics at a conference devoted particularly to the place of creativity in human activity and its relation to integrated education?

I suppose one reason is that physics as a science has been by common consent remarkably successful in achieving the aim it has set before itself. How has this come about? And is it likely that any of the elements of its success can be transferred to other forms of human activity?

Just what is this discipline we propose to discuss? The problem of defining precisely any form of human activity is a very difficult one. One can, to be sure, give brief definitions of almost anything. They become catchwords, more or less meaningless in themselves though they may stimulate trends of thought. For example, somebody has called physics the science of the ways of taking hold of things and pushing them around. This certainly has a engineering flavor and it does produce an idea, but of course it is no more a definition of physics than that given by a somewhat different individual who said that like the city of Boston, physics is a state of mind. This also has an idea in it and perhaps a little more captivating idea than the first.

A philosopher once called physics a vicious abstraction. Physics students find this particularly enjoyable! These "stunt" definitions have an epigrammatic quality, but are otherwise misleading. Ultimately the only way to find out what physics is, is to watch a physicist and see what he does. Ask him what he is doing and hope that you can understand a little of it, in spite of the jargon which he, like all other people dealing with abstractions, is bound to invent. What does the physicist do? Fortunately we can talk about that in the language of ordinary speech. In the first place he restricts his attention to a very small portion of human experience, and in this we have one key to his success. The philosopher who described physics as a vicious *abstraction* had after all a good idea, since the success of physics is due largely to the fact that the physicist does not try to study and describe all experience but only selected bits in which he finds elements of regularity. This is of course an inductive process. It is important indeed to emphasize that the physicist does not confine himself to a merely passive examination of the experience in which he is interested. He wishes to examine it actively and so he does experiments trying to create new experience which was not there before. One can say he is simply discovering things that already are there anyway, but this is just a matter of point of view. The fact is that in doing experiments he really brings into existence experience that was not there before, so far as he is concerned.

But the creation of new experience by experimentation is not enough. The physicist naturally wants to talk about it. Hence he has to introduce concepts or mental constructs, e.g., ideas by which he thinks he can describe the observed regularities more precisely. Using such concepts or constructs he tries to set up laws which are brief shorthand statements of routines that are actually observed. Laws like those of Ohm in electricity and Boyle for gases at once come to mind as examples. The physicist might stop his task with the establishment of these, but actually does not. He builds theories to explain, as he says, the existence of the laws. These theories are logical structures from which the observed laws can be deduced merely by the use of logic and mathematics. Beginning as an *inductive* science, physics has now become a *deductive* scheme based on theories which are postulational or hypothetical in character and which lead by logical deduction to observed phenomena.

Historically, this process dates more or less from the time of Galileo, who is commonly called the

* An address given at the Orono Workshop of the Foundation for Integrated Education at the University of Maine, 1953.

great experimental physicist of his age and who certainly did insist on the importance of experimentation in physics. More important, from our present point of view, he was really the founder of the methodology which we use today in the creation of physical theories.

Let us now indicate briefly the scheme which a physicist uses in this process of analyzing the logical structure of physics.

This also we can talk about in ordinary language and hope to have it understood better than most of the popularizations of contemporary physics, which in their attempts to get across the *facts* make such free use of analogies as often to wind up in hopeless confusion. But I hope we can make clear at any rate the methodology of physics. Its recipe, if we may call it that, starts out in the first place with primitive notions. These are entities we cannot define but which are part of the physicist's mental stock in trade. Just how this comes about is for the psychologists and philosophers to find out. In the case of mechanics, which we shall use as an illustration of the construction of a physical theory, these primitive notions are our ideas of space and time. Now everybody talks about these things and most people feel that they have some kind of intuitive notion about them. And yet if you ask someone what he really means by them he finds it very hard to say. It was St. Augustine who said that as long as you do not ask me what time is, I understand it, but as soon as you ask me what time is, I cannot tell you. Philosophers have long meditated over these notions and psychologists are at length beginning to understand a little about them, but physicists are forced to put up with rather pragmatic use of them from what one might call the operational point of view.

But we cannot expect to get very far in physical theorizing unless we introduce more precisely defined constructs, to use the term which Margenau has popularized. In mechanics, to continue our illustration, such would be the idea of a *particle* as a thing that moves. Moreover its motion must be discussed in terms of certain kinematical constructs like displacement, velocity and acceleration, which can be operationally defined in terms of space and time, as well as dynamical constructs like mass and force. But even with these constructs we can do little at the theoretical deductive level until we have introduced some postulates or hypotheses relating them. This is the stage at which we begin to make guesses. Such guesses in the case of mechanics might be the "laws" of Newton, which are not really laws at all in the sense in which the term is being used in our discussion. Rather they are hypotheses of whose truth we can have no *direct* confirmation. Right here we have a very vivid example of the use of creative imagination in the construction of a physical theory.

Now some who have studied elementary physics in college may think they recall that because the physics professor rolled balls down inclined planes and did other experiments with moving bodies on the lecture table, he thereby proved Newton's second law: force equals mass times acceleration. Unfortunately this never was so, and so far as we know, never will be. Nowhere in physics does one ever *prove* that force equals mass times acceleration. It remains a postulate, and the use of the word "law" in connection with it is misleading terminology, even though now well established in common usage.

Having set up postulates like the principles of motion we proceed to make deductions. For example, by straightforward mathematics we can deduce the law of falling bodies: s equals $\frac{1}{2}gt^2$, well remembered, I hope, from elementary physics. This is the law giving the distance which a body dropped from rest will fall in time, t, in a vacuum.

After the deductions have been made from the postulates of the theory there remains the process of identifying the results with experience, i.e., testing the law experimentally. Its confirmation is the final step in the logical process being set forth. We have thus illustrated very briefly the logical schema of physics as a deductive science in terms of classical mechanics, which is the oldest and most generally successful of all physical theories. Its success indeed has been so great that many people who use it, e.g., engineers, no longer think of it as a theory but rather as established fact. Actually, classical mechanics is just as much a physical theory as modern quantum mechanics, though its constructs seem more familiar and less abstract.

From the standpoint of most people a much better illustration of the logical structure of physical theory is provided by the ordinary Euclidian geometry which most of us studied in high school. It is true that geometry is taught as mathematics but it first developed as a physical theory. You will readily recognize in it the various elements which have already been pointed out. Euclid's primitive notions are his undefined terms like angle, line and plane. His more precisely defined constructs are his figures like the circle, for which he gives rules for construction. These are followed by the axioms and the postulates which from the standpoint of modern logic are all basically hypotheses, in the same sense as Newton's principles of motion. The deductions from the Euclidian postulates are the theorems with which you are all familiar. These, in the terminology we are emphasizing in our discussion, are really the laws of geometry. They can readily be identified with experience by the drawing of figures and the performance of measurements on them. As mathematics, Euclidian geometry stops with the theorems, but as physics it continues to the experimental confirmation of the theorems. There

are indeed distinct pedagogical advantages in including this last step in the teaching of geometry.

In order to emphasize the relation between our discussion and the idea of creativity in physics, it will be desirable to say a word or two about some other physical theories. This is important in order to call attention to what seems to be a historical evolution in the nature of physical constructs. Somehow the constructs of the classical physical theories seem to us very closely connected with experience and have an operational flavor not at all apparent in the constructs of modern physics. We are apt to say that for this reason it is much easier for the average person to get a grasp of classical mechanics than, say, quantum mechanics. Anyone who drives a car does not need to be told in any elaborate fashion what acceleration is. He merely "steps on the gas" and acceleration enters his consciousness as a direct experience. Modern physics seems far removed from this sort of thing.

Let us examine this point a little and instead of taking quantum mechanics as an illustration of a more sophisticated theory let us first choose acoustics. This, to be sure, is a well authenticated theory based on classical mechanics, though by no means as old as the theory of mechanics itself. Its task is to describe what happens when I open my mouth and make a noise, in terms of space, time, and motion, and it will use the same fundamental constructs as particle mechanics with the addition of one fundamental new idea, namely that of a continuous medium in place of a series of discrete particles. When I open my mouth I disturb the air in the room and this is effectively a continuous medium. In fact I squeeze momentarily the air in front of my mouth. Now this medium has the peculiar property that when you squeeze it, it does not stay squeezed. It tends to expand again, or as we say, it is elastic. At any rate, making this assumption and adding to it the constructs of classical mechanics with the laws of motion of a particle applied to the motion of such a continuous medium, what can we deduce? We can predict, for example, just how long it takes for the sound of my voice to travel a certain distance, in other words we can predict the velocity of sound in air. We can indeed derive its precise dependence on the pressure and the density of the air, i.e., we can write a formula for it with exactly the same mathematical precision as the law of falling bodies. This in turn can be experimentally confirmed by laboratory measurements.

We see therefore that the building of a theory like acoustics follows the same logical process as the fundamental theory of mechanics with, to be sure, the introduction of new constructs and postulates which appear plausible enough at first sight. Actually this is only the beginning and even today the theory of acoustics is by no means complete. To give a satisfactory accounting for such phenomena as, for example, the absorption of sound in air, it is necessary to introduce still newer concepts and indeed some from atomic physics. This is particularly necessary to get an understanding of those sounds which are not heard at all, the sounds of such high frequency that the human ear cannot detect them but which to the physicist are now of much greater interest indeed than audible sounds. This is the field of ultrasonics whose important practical applications are now becoming patent to all. Its theoretical study demands the introduction of new and rather esoteric ideas in the logical framework of physical theory.

On a still higher level of abstractness as far as the nature of their constructs are concerned stand the historically more recent theories of electromagnetism and quantum mechanics. What can we say about these? Both theories exemplify an apparent increase in the esoteric character of their constructs and postulates. When Maxwell, who created the theory of electro-magnetism, faced the problem of schematizing the inductively developed notions of men like Volta and Faraday, who had made the fundamental experiments on electric currents and on the relation of magnetism to electricity, he did not simply use these notions that came right out of experience. He had to create an idea — that of the so-called displacement current — which corresponded in no direct or obvious way to anything in experience; but by this act of creative imagination he was able ultimately to construct the electro-magnetic theory of light and to predict that electro-magnetic waves exist and that they travel with a certain definite velocity through space; that prediction was verified by the fundamental work of Hertz, who confirmed experimentally the existence of these waves.

It is well to emphasize at this point that there was a fundamental act of creative imagination involved in the building of the electro-magnetic theory. It was not simply a matter of piecing together experience on a lower level. Where Maxwell got his notion of displacement I cannot really say. This is a matter for psychological investigation. Pragmatically speaking, at any rate, he somehow got it out of his own head.

It is evident that creativity in physics has reached its most advanced and spectacular form in the theory of quantum mechanics. Here we are already dealing with experience which is itself mysterious to most of us because we do not carry around cyclotrons in our pockets. This is a branch of physics in which the cost of creating new experience is very great and science has become truly "big business." Even more mysterious than the "facts" of modern atomic and nuclear physics are the notions which the physicist has developed to describe them. We can say the theory is highly abstract in the sense that the very con-

structs seem to have a relatively tenuous connection with the experience, even on a laboratory level, of the professional experimental physicist. The notion of probability, and the associated indeterminacy principle, illustrate how far the fundamental assumptions of quantum mechanics have strayed from the precision and determinism of classical mechanics.

What I have been trying to get at is that from the historical standpoint we *apparently* have to deal with a kind of progression in the order of abstractness from the older theories to the newer ones, a development in the order of magnitude of free creative imagination at work. At any rate this is the way it seems at first sight. But I believe more careful examination shows that to a large extent this appearance is illusory. In other words, I should like to emphasize that creative imagination was at work just as much when Galileo formed the theory of mechanics as when De Broglie, Heisenberg, Schrödinger and the rest constructed the theory of quantum mechanics. The reason that this does not seem obvious to us is that we are familiar with classical mechanics by a long process of exposure and education, whereas quantum mechanics is still unfamiliar to most of us. We find it impossible somehow to put ourselves into the position of Galileo's contemporaries. But if we were to look back with care into the history of that time, and find out how difficult it was for some of his fellow philosophers to understand what Galileo was trying to say, we should have more respect, I think, for the creative imagination that he exhibited (along with Huygens and Newton) in building the theory of mechanics. For example, the very simple notion of an instantaneous velocity, a velocity that can be fixed at a point in time and then change *continuously* with time, a construct which Galileo had to introduce in order to derive the law of falling bodies, is something that for a long time he could not get many of his associates to understand. Actually, modern teachers find it difficult to get their students today to understand this sort of thing, and it takes a good deal of thought.

If one examines carefully and impartially any physical theory, whether it be old or new, the same element of creative imagination will be found necessarily implied in the elements of the theory. Here then is a very strong link between the activity of the physicist in all ages and all other forms of human mental activity.

At the very beginning it was stressed that one reason why we wished to discuss physics in connection with creativity was the relative success of the method of physics. What now is the nature of this success? Some might be tempted to say that physics more than most disciplines has succeeded in getting at the truth about Nature. I think this is a very questionable view. As far as the physicist is concerned, I do not think he knows what the "truth" is in science, except perhaps with respect to specific experimental facts, and in the context of physical explanation the word appears to be a bad one. Fortunately we do not need to use it in the discussion of physical theories. Rather than talk about the truth or falsity of a physical theory it is sufficient to ascertain whether it is successful or unsuccessful. What then do we mean by the success of a theory? Well, for one thing, a theory is successful if the predictions from it can be successfully identified with experience. That, pragmatically, is the first element in the success of physics as a science, and here of course it has been phenomenally successful.

By itself, however, this element is not sufficient. Physicists wish to feel that in theorizing they have been able to cover a rather wide range of experience. In other words, instead of building a theory for each very small domain of experience, they wish to have it include as much of the world of Nature as possible. If Newton's theory of gravitation were able merely to predict the motion of the heavenly bodies but no others we should not feel very happy about it. We should wish it to apply to particles and bodies of all kinds, and not only particles but continuous media, as was mentioned earlier. In other words, the steady enlargement of the domain of experience which can be described successfully by a given theory is one of the decisive elements of its success. Here again physics has shown itself remarkably successful. Mechanics has gradually spread out until now a very large realm of experience can be described in terms of it with of course suitable modifications, e.g., quantum mechanics and the theory of relativity for small scale experience.

The most striking element in the success of a physical theory is however its ability to predict experience which no one has ever apparently encountered before. This makes a profound impression on the human mind. If somebody comes to you and tells you to take a piece of wire and to do thus and so with it, with the prediction that when you "push the button" a certain result will ensue; and when you follow out the prescribed course of action without having thought too much about it and it comes out in the way predicted, you cannot be blamed for feeling that here indeed is a triumph of the human mind. Probably the prediction of new experience is the greatest of all the elements in the success of physics. Illustrations are legion. Many have heard of the celebrated Irish mathematician and astronomer, Sir William Rowan Hamilton, and his discovery of conical refraction: a peculiar kind of refraction of light that takes place in crystals. This is a special case of the double refraction of light in a crystal like aragonite. As a result of Hamilton's theoretical studies in optics some 125 years ago, he was able to predict the existence of a whole cone of refracted rays in certain crystals. This sort

of thing had never been observed, but one of Hamilton's colleagues, an experimental physicist in Dublin, did the experiment and found the predicted result. There was no very extensive practical application and perhaps it seems, after all, trivial. Actually the fame of Hamilton is not based on that prediction. But it is an illustration of what to most people will remain one of the startling things about this power of creativity, this ability somehow to develop constructs out of one's head and then make predictions that agree with experience. There are many other examples. We have already mentioned the prediction of electro-magnetic waves by Maxwell; and this reminds us that the same theoretical physicist predicted, on the basis of the kinetic theory of gases, that the viscosity of a gas over a very considerable range of pressure is independent of the pressure, again something which at that time had not been observed. In this case, Maxwell himself did the experiment and showed that his prediction was correct.

We have not indeed exhausted the list of criteria for the success of a physical theory. Someone may say we have overlooked a very important one in not stressing the tremendous power to suggest practical applications, the development of those gadgets which have transformed the world. But this gets into the realm of technology and is another whole story by itself. We should not omit mention of the importance of the teachability of physics as a hallmark of its success. Some theories obviously have psychologically a greater coefficient of communicability and this is important in scientific education. Finally, and this is very important, physical theories should be judged by their esthetic quality and the artistic way in which the constructs fit together. Here again we glimpse another bond of union between the physicist as a scientist and his colleague in the arts, who is trying to create something beautiful for his fellow men.

This last indeed suggests an appropriate note on which to bring our remarks to a conclusion. We need very badly to realize that the physical scientist, in his attempt to describe the world as he sees it, is up against fundamentally the same problem as all other people who take an intellectual attitude toward the world. To this extent, we are all in the same boat. Is it unreasonable to plead for a more adequate understanding of the nature of science, and in particular physical science, on the part of those working in other fields of human intellectual activity? Many of my colleagues in the humanities and social studies will perhaps consider this a rather curious statement. For they will say, is it not true that the physical scientists are "riding so high" nowadays that they need no encouragement? Why should anyone trouble himself to understand them or sympathize with their efforts anyway? They are the people who are producing all the trouble in the modern world simply because they went ahead and persisted in learning about nuclear fission and other pernicious things. As acts of creative imagination, they built the theory of quantum mechanics and the theory of relativity and some bright people put the two together; suddenly there appeared the celebrated formula, E equals mc^2, and in due course an atomic bomb emerged with its horrifying potentialities. Are not these people, after all, a miserable lot? In spite of this, they are the ones who get all the money for further research!

Making due allowance for exaggerations, one must confess there is something in this exhibition of annoyance and dissatisfaction. Yet I for one lament it deeply. Without mutual understanding we shall get nowhere. More backbiting on both sides will do no good. Nor is simple tolerance the answer. What we need is that all intellectually-minded persons should unite in wholehearted respect for all achievements of the mind. This can only take place through a genuine effort to understand the fundamental nature and aim of all such achievements. From this standpoint the idea of integration in education assumes a particularly vital significance. In the face of the wave of anti-intellectualism which threatens to engulf our civilization, it behooves all those who have faith in the power of the human mind for the solution of human problems to stand together.

"People often ask what good is an insect? Butterflies are pretty, bees are useful, hornets and others are nasty or destructive. As far as that goes, what good is anything? Benjamin Franklin countered with the question: what good is a newborn babe? Your answer depends on what you think of the universe . . .

"My own feeling, or belief if you prefer such an immovable word, is that the universe is one and its wholeness is all-pervading. I believe, with others, that energy and matter, mind, emotion and spirit are all qualities of whatever this universe is made of, and we separate them because our own consciousness had become aware of them one at a time. I think that wherever a planet exists that is congenial to life, life will evolve, if it has not done so already — not as a visitation from some other place, but as an inborn creation, so to speak, of the planet itself in the light of its sun. The various forms that life can take depend upon the details of the circumstances — and the particular conditions supplied by the evolving earth have led to the peculiar forms of life we see around us and in the mirror. We are all earth-created creatures, with beauty and the love of life inborn in all that lives, from the lowest to the highest; our own uniqueness may lie in our awareness of it." — N. J. Berrill, *Sex and the Nature of Things,* Dodd, Mead and Company, New York, 1953, p. 71.

SCIENTIFIC PHOTOGRAPHY

Herbert Collins

Meaning of Recent Developments In Opening a New World

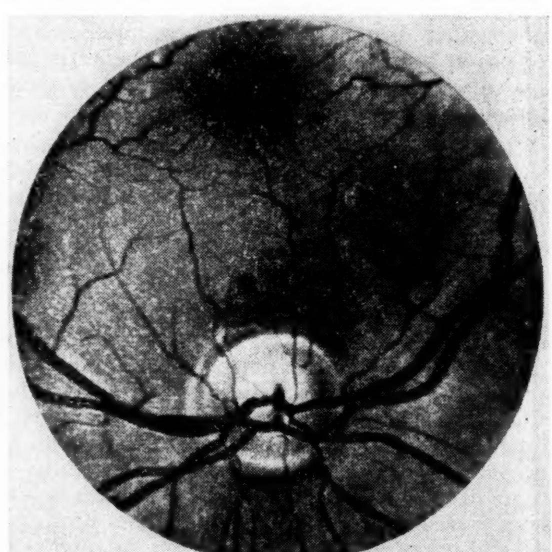
Scientific photography represents the most recent development in the ways of observing the surrounding world with us in it. When the camera is allied with such instruments of vision as the microscope, x-ray, spectroscope and telescope, the world becomes increasingly accessible for human observation. As the camera becomes the means of permanently recording otherwise imperceptible facts, the vision of the investigator of nature becomes enlarged and extended. From bacteria of the soil and plankton in the seas to living spores in the stratosphere and spiral nebulae, the invisible becomes photographically translated into humanly comprehensible terms. A whole new range of mental images, facts and concepts relating to microorganisms, molecular patterns, nuclear structures in cells and atoms, crystallizations, tissues, and extra-stellar bodies are being expounded. This is an important innovation in the development of general literacy concerning nature. Even the most familiar of physical and biological facts and events suddenly appear with unprecedented visual content: remarkably detailed, varied and complex. (See cover illustration.)

The stroboscopic photograph arrests motion. The blur and continuity of ordinary vision are sharpened, halted and individualized. A new world of appearances enters our thoughts and images. Before the hummingbird was stroboscopically photographed there was no way to know what the wings looked like in flight. There was only a fanlike rotation. Harold Edgerton showed the bird's flight in more detail by means of the quick-flash technique. He has renewed our interest in the commonplace.

But the visual explorations of the world do not cease here. The utilization of photopaper and the properties of light-sensitive emulsions have produced the photogram and Lichtenberg figures. These figures are recordings of electric sparks traced over the briefest time intervals on light-sensitive paper. With delicate fidelity, the photogram records a great range of tonal values to which we ordinarily pay the slightest attention. It originates, Laszlo Moholy-Nagy wrote, "as a negative where black becomes white and white becomes black," and reverses "the habitual way of selecting photographic views . . . By this reversal of customary observation a new hidden world arises . . ." [1]

In addition to making discoveries in the surrounding world, these new visual experiences reveal the very process of sight and perception, supporting the findings of physiology and psychology with respect to the functioning of the human nervous system. Besides being limited to certain sound and light waves or frequencies, the nervous system also has a tendency to distort the messages or impressions it does receive. What we eventually see is determined not only by what there is to be seen, but by what we expect to see. The experiments conducted some time ago by Adelbert Ames show that things around us have no meaning except as we ascribe meaning to them. But the meanings are estimates, forecasts and indications. All the ways of seeing eventuate in statements which hypothesize concerning the observable world. In

[1] Laszlo Moholy-Nagy. *Vision in Motion.* Chicago: Paul Theobald, 1949, p. 197.



This reproduction of the human eye is a retinal photograph taken through the eyeball. It is from the collection of Dr. Tille, published in the *Atlas d'Ophtalmologie,* by Tille and Couadau, Masson & Cie, Paris, 1939.

other words, the phenomena of nature are determined by us and by our experiences rather than by a mechanical universe outside us and independent of us.

We have become so habituated to imagining that the factual world is always outside us, that there is a tendency to ignore the neurological sources of all our knowledge. The image of this world varies from individual to individual, yet, as Rudolf Jordan has pointed out in *The New Perspective,* "this is no reason to decry this factual world as a faulty illusion; the imperfection and variability of our senses is a factual phenomenon . . ." [2] Any science or philosophy that affirms vision and discourses on it positively must be abreast of the factual information concerning the nervous system. Otherwise we succumb to Sir James Jeans' dictum: "The history of Twentieth Century science is one of a progressive emancipation from the purely human angle of vision." [3] Quite the contrary, the refinement of the instruments of vision brings the world closer to us and subtilizes all our experiences. The visual impact of photography enables us more adequately to appraise the world and the part we play in it.

We are presented today with a factual world of great diversity and rhythmic pattern. There is grist for our imaginative curiosity and intellectual reflection in the permanent recording of radiolari, diatoms, crystals, mitotic divisions, stress patterns, and carbon molecules. Radiograms of plants, animals, intricate machinery, and all hard surfaces augment exploratory observations and amaze us with the transparency of solids. The cosmos in a droplet of pond water, the pictorial expression of sponge spicules and air bubbles, the visualization of Doppler effect in ripples, the crystals of hippuric acid, the unexpected transparency of the wasp, and the eggs of a moth are unforgettable discoveries. All this affirms the factual and esthetic content of the world, and delivers it to us on a level that does not de-humanize. What is impressive is that the photographic statements modern science creates are the visual documents of phenomena which science otherwise has claimed could never be pictorially communicated. Idealists in science such as J. W. N. Sullivan have been prone to sacrifice vision for abstract constructions, dismissing "the pictorial imagination" as of no service "to modern intellectual constructions." [4] Photographic techniques counteract this etherealizing of the world, and establish contacts with the world that no amount of mathematizing can ever replace. It is this that stimulates interest in nature, restores the position of the naturalist, and relieves us of those transcendental abstractions which are unnecessary for the processes and structures *in* nature.

This recent development in the modern discovery of the world started with the enlargement and extension of vision which the lens, geometry and the compass began some six hundred years ago. Ever since, the modern attitude of observing has left no field of knowledge and belief undisturbed. During the Middle Ages, artists and naturalists refrained from literally transcribing the visible contents and appearances of nature. There had been a studied effort to learn nature's processes in order to unfold before all spectators an authoritative version of God's creation in a language all men could comprehend. The visible content of art and science was a mixture of what was ordinarily seen and authentically written for devotional ends. In art this was often accomplished by exaggeration, fantasy, grotesquery, stylization, and frequently by accurate copying in order to reveal the invisible in familiar terms. The result was never so concrete as to divert attention to this world at the expense of divinity and perfection. Only grudgingly did the artists and naturalists abandon the contemplation of a world radiant with revelation. "The Middle Ages had definitely ceased to exist," one student of the period points out, "when art became so busy with the visible as to forget the invisible beyond." [5] Symbology lapsed, or rather the interest in symbols was swamped by the greater interest in nature for its own sake. With every departure from conventional art and science, at the insistence of incipient nominalism, empiricism and mimeticism, the immediacies of concrete experience and physical actualities were explored. Skill in viewing and skill in rendering what could be seen took precedence over the sanctity of ideas. What was first an intrusion turned out to be an assault.

The most consequential result of all this has been that in science, technology and art the phenomena of this world have been investigated in order to know what takes place. Then through imaginative and creative acts of workmanship and invention, the knowledge of such conditions has been rendered into languages and objects for human use. The objects which issue from any technology, be they axes or dynamos, are not imitations, copies or replicas of the observed world. The implements and machines which sustain any technology or constitute its progeny merely use the structural method of nature in attaining technological ends. There is no model in nature for the tunnel, the jet or the skyscraper. Nature teaches us the method and structural conditions by which to solve problems. The limiting factor in our making and thinking resides in the very structure of the universe. After all, the purposes we set and the values we spin succeed as we learn

[2] Chicago: University of Chicago Press, 1951, p. 11.

[3] Sir James H. Jeans. *The New Background of Science.* Cambridge: The University Press, 1934, p. 5.

[4] *The Limitations of Science.* New York: Mentor Books, 1949, p. 39.

[5] Bede Jarrett. *Social Theories of the Middle Ages.* Westminster, England: Newman Book Shop, 1942, p. 268.

the methods, structures and processes of what we want to handle and what we want to know. Every invention, therefore, is ostensibly a discovery. Awareness of the discovery may not always occur when an invention is made, but the criterion of a successful invention has always been that it "works." Such constructions are, however, not so much documentary recordings of what exists in the world, as exhibits of human creativity and testimonials of what can be done.

Art, science and technology are records of the reciprocity between man and his surroundings. Historically they display the conditions of living which men have made and accepted, their understanding of the universe, and the symbolic representations of what men are either capable of seeing and thinking about, or are predisposed to see and think about. These are the modes of expression that characterize what it means to be human and what it means to operate in what George Santayana called "an environment in which everything is not already what man is presently to make it." [6] The foundations of art, science and technology are in the prevailing understanding and manipulation of the surrounding world. The thousand new things to see and the thousand new ways of seeing are wasted whenever there is no established ordering principle through which to organize the new visible world. The chief obstacle to our recognition of this problem has always been the habit of expecting the world to conform to and confirm familiar ways of seeing.

New scientific and philosophical concepts such as discontinuity, elasticity, nonsimultaneity and indeterminacy have been abstracted from the new world which has been made visible. The ninety-degree angle becomes a limited experience. What the Renaissance artists, physiologists and anatomists discovered about the human body cannot compare to an x-ray view or even to the discovery of the colloidal organization of the living cell, with its nucleus and chromosome pattern which art and medicine have yet fully to comprehend and apply. The space of Seventeenth Century physics and its counterpart in the Baroque garden and palace were magnificent exaggerations in comparison to the space of the atom or the gravitational field of a spiral cluster of stars. Scientific photography has regained the point of view of vision which the infatuation of early modern science with numbers and measures almost lost for us. Recently when the interpretation of "meter readings" became fashionable, Sir Arthur Eddington described one of those de-humanized observers who with one undamaged retinal point on the eye's surface could still read the coincidence of two lines.[7] We challenge such nonsense with our human apparatus of vision, and observe without reliance on an equation or a moving point across a scale. We are not yet reduced to numbers.

The difference between a meter-reading and a photograph occurs on the level of communication where the degree of abstractness will vary. The meter-reading encourages mathematical abstractions and accentuates the separateness of men and the world they inhabit. Photography joins vision and intellect in a partnership that utilizes all the nervous system. Since the Renaissance, the artists have shared with the scientists the same outlook of going to nature. The visual experiences out of which all knowledge and art are created have become so magnified that no past experiences and expectancies can any longer satisfy. What we can expect from art today is no different from all the other yesterdays: experimentation, observation, curiosity, fantasy, abstractive simplicity, and a correct view of the factual world which the sciences are prepared to serve. The task of the artist has always been to visualize and reason about himself and his environment in an ever more accurate manner, and to represent the reactions of men to the world. The occurrence of idealistic abstractions and the denial of nature in some contemporary paintings often indicate a failure on the part of some artists to recognize their historical and intellectual function. "The more one departs from nature," Aristide Maillol once wrote, "the more one is an artist; the more one approaches nature, the more the work becomes ugly." [8] By claiming that nature is arid, certain artists have merely confused the richness around them with their own conceptual ineptness. "The artist must not copy Nature," Gauguin perceptively and correctly wrote, "but use the elements of Nature to create a new element." [9] Yet some artists have imitated the scientists, which is something worse than imitating nature. The contributions of the scientists are to be found in their discoveries of the world, and not in their abstractions or calculations. Every new discovery of the world around us constitutes a new way of seeing ourselves and our environment, and heightens the possibilities of new inventiveness.

At the root of the world outlook of today are the unexpected forms of natural phenomena that scientific photography makes tangible through visual data. These forms constitute factual as well as esthetic material. But the artists have been backward in exploiting the esthetic content. This is explained by the fact that they have been over-impressed with the abstractions of the scientists. They have neglected and ignored the findings. The esthetic experiences of scientists are notoriously limited. Physical scientists especially have accepted and sponsored a Pythagorean approach to art.

[6] *Life of Reason*. 5 vols., New York: Charles Scribner, 1923, vol. IV, 28.

[7] *New Pathways in Science*. New York: Macmillan, 1935, pp. 12-13.

[8] Cited in Charles J. Biederman. *Art as the Evolution of Visual Knowledge*. Red Wing, Minn., 1948, p. 470.

[9] *Ibid.*, p. 285.

They have presupposed simplicity and uniformity in nature which their mathematical abstractions have confirmed. They have revelled in the neatness and perfection of the phenomena they have located. The facts they have established have usually been expressible in equations of quantitative simplicity which further exaggerated their esthetic postulates. A theory of beauty subsequently became attached to the sciences that resembled the canonical importance of perspective in drawing and painting. The world became identical with geometry, which was still inarticulately three-dimensional. Seeing was believing. Abstractions were more real than particulars. The laws of nature were more perfect than the underlying processes in nature. Together, the scientists and the artists constructed a rigid system of the world based on their perceptual experience of inertial objects and systems like planets, mountains, animals, plants and men. The constancy and stability of these were mathematically and mechanically explained by the laws of gravitation.

It is historically significant that the invention of the camera, the modern study of light, the discovery of the nuclei of cells and atoms, and the admission of time into the dimensions closed an epoch in knowledge and esthetics. The estimate of the universe based solely on mechanical and mathematical abstractions has come to a close. It has fallen to scientific photography to make public these findings in visual demonstrations of the utmost interest and stimulation. The translation of so much phenomena onto the two-dimensional plane of the photographic print creates conditions that are comforting to human intelligence. Scientific photography has done for our age what mathematics did for our predecessors. It has translated into terms that are humanly manageable events and facts of great complication. And like mathematics, it can lead men to new reflections and inquiries. It can facilitate the noticing of further facts. It can assist men further to organize and integrate their environment. We are concretely presented with the stuff out of which new mental images are formed and old ones revised. For sheer growth of information, scientific photography is inestimable. Artists may find in scientific photography the clues to nature's ways on which great art is founded. By substituting vision for measurement, where possible, we dispose ourselves to view the world less abstractly and, it may be, more correctly.

INTEGRATIVE PROGRAMS IN COLLEGES

ST. MICHAEL'S COLLEGE

St. Michael's is a Catholic college, with an enrolment of about seven hundred boys, located in northern Vermont. From its foundation in 1904 to 1925 only one degree, the Bachelor of Arts, was offered. In 1925, a two-year pre-medical course was introduced. Two other programs of studies were introduced in 1927, the degree of Bachelor of Philosophy, and the degree of Bachelor of Science. Diversification continued from 1934 to 1942, when the program of majors and minors was introduced.

With the pressure of excessive enrolments relieved after 1950 and with more time to spend on studying the problems of the curriculum, the way was prepared for a determined effort to solve them. We shall try to present the important conclusions reached by the faculty.

The question of aims is perhaps the most important that a college educator can ask himself. For those who accept the Greco-Christian explanation of the nature of man, it would seem that a philosophical analysis of human nature must leave the educator with the conviction that his work is primarily one of enlightenment of the intellect. The curriculum must be designed to carry out the aims of the college, which are primarily this intellectual formation, and must be carefully correlated with the admissions policy. At St. Michael's, this policy is to admit to the freshman class any student who is judged by a committee of three to possess the basic, indispensable abilities.

In any college, the choice which it makes of the courses of study, the emphasis which it gives to one field of knowledge in preference to another, will inevitably reflect its conception of the nature of man and of the relative importance of the realities of man's world. It is difficult to conceive how a well-integrated curriculum can be produced by men who have no common agreement on these fundamental points.

In the Church-related college, and more specifically the Catholic college, the members of the staff are in agreement as to the nature of man, his destiny, his relation to the world. This agreement constitutes a unity of thought which is already an

important integrating element, and it suggests what fields of study should be considered basic.

Integration means much more than just "joining together" scattered parts. It implies organization, and organization in turn implies that the various parts which make up a whole are placed in relation to each other according to their importance. An integrated curriculum will then be one in which all courses are so organized that the more important are in a position of prominence and the less important are in a subordinate position. There can be no doubt in the minds of Catholics that in such a curriculum the nucleus must be theology. The heterogeneous parts to be organized around this nucleus are the natural sciences, philosophy, etc.

To have an integrated curriculum there was need, then, of placing in it all the fields of learning in answer to the question: What should a graduate of St. Michael's College know? There was need of giving to theology and philosophy a central place in that curriculum. There was need of unifying the study of history, literature and art. There was need of including the principles of political, economic and social life. A discussion of mathematical thinking was required. An opportunity of penetrating more deeply into one field of knowledge, while avoiding specialization, had to be offered.

The revised curriculum, we believe, incorporates all these objectives.

The Freshman year is devised to do three things: (1) remedy weaknesses in the student's background, (2) lay a solid foundation for the advanced work of the next three years, and (3) allow the student the time and opportunity to choose his field of concentration. All students are required to register for full-year courses in English, mathematics, science, in a modern language, and a course in orientation entitled Basic Principles of Knowledge. To these is added, for most, the basic course in Air Science. The course in Basic Principles of Knowledge is made up of four parts. The first consists of a thorough discussion of the nature and aims of liberal education, the second deals with practical logic, the third and fourth parts consist of introductions to philosophy and theology. This course might be considered the first coordinating course in the curriculum.

Each student's progress is carefully watched by his adviser as the year advances. By the end of the year the student should be ready to make his choice of the field of concentration: Business Administration, Biology, Chemistry, Economics, Education, English Literature, French Literature, History, Latin, Mathematics, Philosophy, Political Science, and Sociology. During their second, third and fourth years all students, no matter what their concentration, are required to follow three courses which are the same for all: The Sequence in Humanities, a three-year integrated course in the history of western civilization; The Sequence in Philosophy, comprising The Philosophy of Nature, The Philosophy of Being, and a History of Philosophy; The Sequence in Theology, using the Summa Theologiae of St. Thomas as the basis of the three-year sequence. The Senior Coordinating Seminar, to integrate the student's knowledge of his special interest and of other fields in relation to it, is required in all fields of concentration.

Under the new program only one degree is awarded, the Bachelor of Arts. There is no reason any longer to offer any other, because we are firmly convinced that, no matter what field of concentration is chosen, the student when he graduates will have acquired a liberal education.

— Rev. Gerald Dupont, Dean

SMITH COLLEGE

There are two groups of interdepartmental courses given by the science departments at Smith College. The first group consists of courses for the fulfillment of the distribution requirement in science; these are open to freshmen and sophomores. In the physical sciences there are two: "The World of Atoms," "The Earth in Time and Space." In the first of these material has been very carefully chosen from the subjects of chemistry and physics in such a way that modern theories of atomic structure can be logically developed. The lecture demonstrations are carefully worked out and conclusions to which such experiments lead are explained. There is no individual laboratory work. The material is carefully integrated and although the two members of physics and chemistry departments involved in giving the course lecture in their own fields, each carries a recitation section throughout the year.

In "The Earth in Time and Space" the main theme concerns the origin of the earth, the solar system, and the universe. In the first few weeks a member of the chemistry department presents the chemistry useful to the geologist. The physicist at various times during the year presents work in forces, in light, and in radioactivity. The director is a geologist and geology forms the fundamental theme. Laboratory work, field trips, and work in the observatory form an integral part of the course.

The departments of zoology and botany cooperate in a course entitled "The Living World" in which is presented life as exhibited in the form, function, inheritance, and evolution of living organisms, with special emphasis on the relationship of man to the equilibrium of nature. Use is made of individual laboratory work as well as demonstrations. The course is a very well integrated one and has proved very popular.

Another and very different type of interdepartmental course has just been started, open to juniors

and seniors (except those who are majoring in any of the fields concerned). The "Frontiers of Science" as developed in the physical sciences includes four topics chosen on the basis of two criteria: the material must be explicable in terms that can be understood by students who have no background in the field; the topic must end with a question mark. Last year the topics chosen were: "Cosmic Rays" (treated from the historical point of view); "Crystals and Atomic Architecture" (presented from the point of view of symmetry); "Stellar Universes" (the evidence of different types of stars, clusters, and galaxies was given); "Waves and Particles" (first the evidence and then the philosophical discussion). There is no attempt to integrate the different sections, but one of the most striking conclusions drawn by the students from lectures last year concerned the essential unity of science. They expressed in various ways an awareness of science as a search for truth and as an exciting intellectual adventure.

A semester also called "Frontiers of Science" is being offered this year by members of the biological science departments. They have organized a series of topics concerning the effect of food supply on the present and future status of man. There will be included such topics as: photosynthesis, new energy sources, ersatz food, radioactive tracers, hormones, Russian genetics, viruses, antibiotics, and bacteriological warfare.

The elementary interdepartmental courses described have established themselves as valuable parts of our curriculum. The advanced courses are still in an experimental stage.

—Dr. Nora Mohler, Dept. of Physics

SOUTHERN CALIFORNIA COLLEGES

Dr. V. L. Bollman, Professor of Physics at Occidental College, calls our attention to "An Intercollegiate Program of Graduate Studies in the Humanities and Social Studies" being instituted at seven liberal arts colleges in Southern California under grants from the Fund for the Advancement of Education of the Ford Foundation.

The participating colleges are: Claremont College, Claremont Men's College, Pomona College, Scripps College, Occidental College, University of Redlands, and Whittier College.

"The central purpose of this program is the development of improved means of preparing college and university teachers." A higher degree should "represent attainment of competent scholarship and some demonstration of capacity for independent investigation" and "an ability to understand and evaluate the subject matter of a specialized area with cognizance of its fundamental relationships to other areas of knowledge and to the existing interests of society and civilization."

The program consists of weekly inter-subject seminars on "Society and Ideas in Flux" and "Institutions and Loyalties." "Issues of significance to students and teachers in the program" will be explored in fortnightly dinner meetings that will help in "achieving the common background and understanding that the inter-subject seminars are designed to create."

SOURCE READINGS: INTEGRATIVE MATERIALS AND METHODS

Points and Spaces in Mathematical Philosophy

In the first 1954 number of the *Canadian Journal of Mathematics* there appeared an article entitled "Points and Spaces," by L. E. J. Brouwer, founder of the intuitionist school of mathematical philosophy. This school differs fundamentally from the vast majority of working mathematicians in its views on what constitutes the nature of mathematical truth and the correctness of mathematical reasoning. This review will attempt to describe the background of this clash of standpoints.

The difficulty arises in the conception of the infinite. Hermann Weyl has characterized mathematics as "the science of the infinite." Hilbert, one of the great mathematicians of this century, wrote: "The infinite, like no other problem, has always deeply moved the soul of man. The infinite, like no other idea, has had a stimulating and fertile influence upon the mind. But the infinite is also, more than any other concept, in need of clarification." The mathematical infinite arises in two contexts: First, in the counting of discrete individuals, from which there arises the integer series 1, 2, 3, . . .; secondly, in the measurement of continuous magnitude, the infinite divisibility of which leads us to regard the line as composed of an infinity of dimensionless points.

Now these mathematical infinities have two conflicting aspects. On the one hand, they are suggested to us by our finite experience. Thus, whatever whole number we may have constructed, by

counting or otherwise, at any given time, we can always construct a larger one, and again a larger one, and so on without limit. But the important point is that, at any one time, only a finite number has been reached. Thus the mathematical infinite appears as a potential, never an actual infinite. In this respect it is fundamentally inferior to the Infinite of religion, which is an actual present Infinite, but not of the senses, and unimaginable to our sense-bound minds. On the other hand, though suggested by sense experience, our intuition of the mathematical infinite does carry us beyond sense experience. It does not admit physical limitations as relevant to its validity. Even if all the individual atoms in the universe were to prove finite in number, we would still believe in the existence of integers vastly greater than that number. We are reminded of the philosopher-mathematician Plato, according to whom the world of matter assists us to acquire knowledge by "suggesting" to us the ideal realities.

It is this conflict, between the finiteness of any action or construction in time and the infinity of our intuition, which gives rise to the difficulties of the mathematical philosophy of the infinite. Consider, for example, how we discover the truth or untruth of propositions about whole numbers. The proposition, "all numbers from 1 to 100 are products of prime numbers," is a statement about a strictly finite collection of numbers; it can be verified by the finite process of checking all the numbers in question. But the universal statement, "*all* numbers are products of prime numbers," is of a very different nature. We cannot test every one of the infinite system of whole numbers. To verify the truth of this statement, we must apply logical inference based on the elementary intuitive properties of number, in this case mathematical induction. But logical inference, or proof, differs in an essential respect from a routine survey of a finite collection of given objects. The latter is secure and certain; in principle it can always be carried through, given sufficient labor. But logical proof requires perspicacity, creativity; one cannot be assured ahead of time that one will find it. The same applies to a statement of existence, such as: "Among all numbers, there exists at least one having such and such a property." This cannot be decided, for an arbitrary property, by a routine check. Rather, one attempts to construct, out of the infinite manifold of possible numbers, one having the required property. But, as before, the attempt is uncertain of success, and a genuine creative effort. In general, there is no a priori reason for maintaining that an arbitrary statement about the system of whole numbers must eventually be either proved or disproved. In fact, the remarkable work of Gödel has shown that, in an exact sense, there exist propositions about the number system which are incapable of being decided one way or the other. One may speculate whether Fermat's so-called Last Theorem, stated by him in 1637 and, in spite of enormous effort, never yet proved or disproved, may be one such proposition! In spite of its transparently intuitive character, the number system, like the world of physics or biology, conceals qualitatively unlimited possibilities, beyond the reach of any finite survey.

But if there are propositions which can never be proved or disproved, what becomes of the principle of the excluded middle, "either A or not A"? Certainly it cannot be constructively verified for the infinite in the same sense that it can for the finite. Two choices are open to us. On the one hand, as most mathematicians do, we accept the principle of the excluded middle as unconditionally valid for infinite as well as for finite systems. But here again we enter a realm which transcends finite experience. Or, on the other hand, one may, with Brouwer and the intuitionist school, determinedly reject all judgments not supported by finite constructive experience, even such an elementary logical judgment as "either A or not A" when A is a proposition about the infinite.

Though we have so far spoken only of the whole numbers, it is not the whole number system which has caused most perplexity among mathematical philosophers. The real trouble begins with the continuum. What is the continuum of our experience? Unlike the whole number system, which consists of separate discrete objects, the continuum is presented to us as a *unity*. Its parts are not discrete; indeed, some philosophers have maintained that there are no parts, actually existing as such, separate from one another in empty space. But the analysis of the motion of matter seems to make unavoidable the concept of indivisible dimensionless points composing space. The logical analysis of this concept is not easy. Only in the last century, through the work of the German mathematician Cantor (who, incidentally, had a thorough training in philosophy), was the analysis of abstract infinite sets developed into an exact logical system. But Cantor's work met bitter criticism. Some argued that Cantor's proofs were mere words, without constructive content. To appreciate this criticism, we recall that, even for the whole numbers, the principle of the excluded middle is incapable of finite verification. But Cantor had applied unrestrictedly all the principles of elementary logic to infinite sets vastly more complex and less transparent to intuition than the whole numbers. For example, let us compare the set of whole numbers with the set of all points on a line. Though the former is infinite, yet any number in it can be reached by counting; each represents a possibility of finite experience. But logical analysis of the set of all points on a line shows that there must exist among them an infinity of points, no one of which can ever be reached, that is, be defined or specified, in a finite time! Even all possible combinations of words of any conceivable finite length are inade-

quate to distinguish all the points of a line one from another.

Further than this we cannot go. What has been said may indicate why some mathematicians revolt against an air of unreality which surrounds the modern theory of the continuum, in spite of its superb logical structure. Foremost among these is the "intuitionist" school of Brouwer, which eliminates from mathematics all non-constructive arguments based on the application to infinite sets of the principle of the excluded middle. But, in practice, the refusal to admit this principle so hampers mathematical reasoning that few mathematicians are willing to follow Brouwer's lead, so long as positive contradictions do not arise out of the freer methods. Of this school Hermann Weyl writes: "Mathematics with Brouwer gains its highest intuitive clarity. He succeeds in developing the beginnings of analysis in a natural manner, all the time preserving contact with intuition much more closely than had ever been done before. It cannot be denied, however, that in advancing to higher and more general theories the inapplicability of the simple laws of classical logic eventually results in an almost unbearable awkwardness. And the mathematician watches with pain the larger part of his towering edifice which he believed to be built of concrete blocks dissolve into mist before his eyes." — *J. M. G. Fell*

LIBERAL EDUCATION IN PROFESSIONAL CURRICULA

"Liberal Education in Professional Curricula" was discussed by V. M. Hancher, President of the State University of Iowa, in the March, 1954, issue of the *Journal of Engineering Education.* The author describes a person with a liberal education as one who has comprehensiveness and breadth of knowledge, understanding and insight, tolerance and urbanity. He is expected to use his knowledge, combined with vision and creative power, to harness the forces of nature and work for the establishment of the "good" society.

There are two serious obstacles to the achievement of this goal: time and money. "We must put away the wasteful competitive and duplicating efforts which have been a disgrace to American higher education during the last decade and which have done as much as any single thing to bring it into public disrepute and to give aid and comfort to those who oppose and may even hate us."

Dr. Hancher explains that the land-grant colleges found it more acceptable to introduce traditional courses from the liberal arts colleges or to establish what were in effect schools or colleges of liberal arts within their institutions. They did not, as far as he can discover, develop a new or different concept of how liberal education can be achieved.

"What we need in our land-grant colleges and universities and institutions of technology are teachers of professional and specialized subjects who see their subject matter in relation to the whole field of modern learning and modern civilization."

Dr. Hancher thinks that it is the responsibility of the institution, perhaps its most important responsibility, to determine what is fundamental, to teach that which is fundamental, and then to put the student on his own.

"If this can be done, thousands of young men and women who otherwise might become merely narrow technicians will become not only able and effective citizens, but even their professional competence will be heightened, because their eyes have been opened and their horizons widened to things far beyond their childhood gaze. And because we have taught them imaginatively, they will be stimulated to be students as long as they live." — *W. E. Howland*

DYNAMIC HOMEOSTASIS AS A UNIFYING PRINCIPLE

An article by Alfred E. Emerson ("Dynamic Homeostasis: A Unifying Principle in Organic, Social, and Ethical Evolution," *Scientific Monthly,* 1954, LXXVIII, pp. 67-85) points to significant similarities in the evolutionary development of fundamental biological and social processes. It reviews the concept of homeostasis as applied in the physiological sphere by Walter B. Cannon, and in the social sphere by Ralph W. Gerard and others. It makes clear that ethics and economics are important aspects of human social evolution and that the over-all trend of social as well as of organic evolution is toward increasing homeostasis.

Emerson points out that the principles of natural selection work for the preservation of the group or species and not necessarily of the individual *per se*. Individual strength or power may be self-defeating and lead to extinction if used in a way harmful to the social group. Although competition between individuals within a biological species occurs at times, it is less prevalent than between species. Since the human species is a genetic and cultural unit, "individual exploitation of other individuals . . . is harmful and will be negatively selected, whereas cooperation, integration, division of labor, and balanced compromise usually result in an increase of efficient homeostasis for all concerned and will be positively selected."

Newer biological principles, then, do not support our earlier view of "Nature, red in tooth and claw." Rather, they support the concept of the

"brotherhood" of mankind and of an "ethics leading to firmer integration and mutual benefit between races . . ." In this development human social and international behavior, governed now so largely by emotionalism, will increasingly be brought within the domain of such an organismic orientation as that envisaged by Trigant Burrow.

The unifying effect of a consistent application of the principle of homeostasis at different integrative levels is dramatically presented in these closing remarks of the author: "It relates the individual to the group, divergence to convergence, competition to cooperation, isolation to integration, independence to dependence, conflict to harmony, life to death, regression to progress, conservatism to creativity, organic evolution to social evolution, psychology to biology, emotion to intelligence, the conscious to the unconscious, science to ethics and esthetics, reality to value, and means to ends."

— *Dr. William Galt*

GRADUATE ENGINEERING PROGRAM IN NAVAL ORDNANCE PLANT

In the March, 1954, issue of *The Journal of Engineering Education,* W. E. Howland and G. A. Hawkins discuss a "Graduate Program in Engineering at the U.S. Naval Ordnance Plant in Indianapolis, Indiana." An earlier report on this program may be found in *Main Currents in Modern Thought,* V. 9, No. 1, pp. 28-30.

Purdue University has offered graduate instruction in several industrial centers of Indiana for some time. The U.S. Naval Ordnance Plant at Indianapolis requested that the University offer a curriculum of graduate instruction for their employees. The type of program chosen was "an integrated one — a definite attempt to bring together a coordinated group of courses at the graduate level that would be of value" to mechanical, electrical, civil, and perhaps chemical engineers.

The committee responsible for formulating the details of the program believed that it was worthwhile to coordinate engineering knowledge and methods at the master's level.

"Thus the key word to describe the purpose of the new curriculum is 'integration' — the making of a whole out of an infinitude of infinitesimal parts. The parts are the innumerable facts that the student accumulates in the course of his reading and schooling and working; the whole is the supporting of those facts on the skeleton framework of the fundamental laws and principles of engineering science with the vital connective tissue of mathematics and then their control through a sort of central nervous system that we call 'mode of analysis.' "

The committee formulated what they called the modes of analysis that are employed in the several fields of engineering sciences to try to determine a general pattern common to them all. ". . . In this venture we were successful. The pattern is common to all of the kinds of problems that engineers as engineers are expected to solve. And we personally believe that it applies to all fields in which problems can be solved."

The authors indicate that it is too early to attempt an appraisal of the curriculum. However, some modifications will be made to simplify and rearrange the material of the mathematics courses. ". . . Good curricula like good laws cannot be merely enacted — they must grow!"

"This curriculum follows what appears to be a modern trend of 'integration' which has manifested itself in the whole field of education as well as in engineering education. But in a real sense we are pioneering. We are proposing to abandon conventional subject matter boundaries, to reshuffle the deck of engineering facts in a new way and to play the game according to somewhat different rules. Instead of constructing a master's degree program so as to proceed further into a particular specialty from the base of previous training, we are proposing to broaden and to strengthen the foundation itself. Thus, we hope to help our students erect a deeper and stronger structure of knowledge on which eventually an even higher and certainly a stronger one will be erected than would otherwise be possible." — *Ruth Lofgren*

RECENT CONCEPTS OF PROBLEMS OF THE SELF

In a recent issue of the *Journal of Consulting Psychology* (1954, *18,* No. 2), two independently prepared articles deal with the problem of the self. The study by Robert E. Bills of the University of Kentucky ("Self Concepts and Rorschach Signs of Depression") uses Rorschach projective technique and arrives at the conclusion that most people think of themselves in terms of two distinct ideas, one described as "the perceptions of self" and the other as "the ideal self." The two often differ to a considerable degree, for the simple reason that it is difficult, especially under conditions of high individualism, acute competition, and general complexity of our civilization, to live up to what one expects of himself, hopes for, and aims at. Whenever the discrepancy between the two selves, real and ideal, is high, signs of mental disorganization and depression usually appear. Whenever, on the contrary, the discrepancy is low, the fact is indicative of a relatively good social adjustment. Mental health obviously requires not to aspire too high, certainly not beyond one's likely reach.

The other article, by Emory L. Cowen of the University of Rochester ("The Negative Self Con-

cept as a Personality Measure") uses self-rating in order to determine the degree of subjects' social adjustment. It does so in terms of the "positive" and "negative" self-concepts. The author's analysis of self-ratings shows that persons with high negative self-concept, that is, persons who are aware of, and frank about, their deficiencies are better adjusted to their environment than persons with low scores. It so happens that the former manifest "a more stable self-picture" and are less predisposed toward authoritarian attitudes.

Both articles seem to demonstrate that no concept of the self can be precise by itself. Practical psychological considerations demand that the problem be expressed in terms of two concepts, the real self and the ideal self, the actual relationship of which determines one's ambitions and purposes, happiness and success, adjustment, stability of personality, and mental health.

— *Ralph B. Winn*

SYNTHESIS IN SCIENTIFIC EDUCATION

Ludwig von Bertalanffy's article ("Philosophy of Science in Scientific Education," *Scientific Monthly,* 1953, LXXVII, pp. 233-239) is a strong statement on behalf of the unity of science and the need for integrative education. He emphasizes the fact that scientific progress is largely dependent upon the interrelationship and synthesis of different fields of endeavor. The author denies that the viewpoint of physicalism is the only valid outlook of science, and holds that unification can be achieved only through "some uniformity of the conceptual schemes, the symbolic constructs in science." Attention is called to the fact that in modern science "similar concepts and principles have arisen in quite different realms, although this parallelism is the result of independent developments, and the workers in the individual fields are hardly aware of the common trend." Himself a pioneer in the development of the organismic conception in biology, von Bertalanffy shows how principles of wholeness, of organization, of a dynamic conception of nature have recently come to the fore in such diverse fields as biology, psychology, and the social sciences. Such parallel developments have led him to postulate a new basic scientific discipline called *General System Theory* which can "develop model conceptions applicable to different fields . . ." — *Dr. William Galt*

LIMITATIONS ON SCIENTISTS

In the January 29, 1954 issue of *Science,* Freeman H. Quimby, of the Physiology Branch, Office of Naval Research, comments upon the question of the limitations imposed on scientists in regard to travel and security, and expresses his belief that they are merely symptoms of a growing distrust of science and scientists. (He speaks, of course, for himself, and not officially for the Navy Department.) Mr. Quimby quotes a considerable number of expressions of this distrust which have appeared in print, and which he believes reflect attitudes now in ascendance.

Some of the causes of the adverse development appear to be: the concept that science and religion are in opposing camps, the internationalistic outlook of scientists, the social neutrality of science, fear and resentment of the "destructive" power of science, and the extraordinary scientific illiteracy in America even among intelligent, educated people. Mr. Quimby suggests that the situation demands further study of causes and solutions, and in particular a deliberate effort to disseminate widely the story of science and the habits of thinking which underlie it. He feels that government scientists, especially those dealing with administration and policy matters, are in a unique position to contribute to this effort, and suggests that the initiative in meeting misunderstanding and unjustified criticism should be taken by one of the three existing agencies: the National Academy of Sciences, the American Association for the Advancement of Science, and the National Science Foundation.

INTEGRATIVE MILITARY HISTORY

A summary by Gordon B. Turner of the "Interim Report of the Committee on the Military History Project" at Princeton University describes the problem many colleges face, that of integrating military instruction in the normal curriculum.

A course in "The History of Military Affairs in Western Society Since the Eighteenth Century" has been developed and taught by the faculty of the History Department. ". . . The purpose of the course is to analyze the civil as well as the military aspects of modern total war so that the student will gain a perception of the relationships involved. The intent is to familiarize the student with the vital problems which wars raise in democratic society and, in accord with the liberal arts process of education, to keep his mind flexible in regard to these problems."

"An evaluation of the course reveals that the concept is sound. R. O. T. C. students agree that the study of civil-military relations tends to unify the two parts of their academic program. The History Department has endorsed the program, and by agreement between the University and R. O. T. C. officials, the course has been instituted as a regular feature of the R. O. T. C. curriculum at Princeton."

A syllabus is being prepared that will include suggestions to instructors, lecture outlines and bibliography. — *W. E. Howland*

REVIEWS

Jung's Principle of Acausal Connections

For those who have followed C. G. Jung's explorations into the deeper layer of the psyche it has been fascinating to watch the development of his last thesis, Synchronicity or the Principle of Acausal Connections. Thirty years ago Jung stated in discussion of the *I Ching*, the Chinese *Book of Changes*, "The science of the *I Ching* is not based on the causality principle, but on a principle which I have tentatively called the synchronistic principle."

Synchronicity, (*Naturerklärung und Psyche: Synchronizität als ein Prinzip Akausaler Zusammenhange* (*Synchronicity: the Principle of Acausal Connections*), by C. G. Jung, 107 pp., Rascher Verlag, Zurich, 1952, $4.75) originally published in German with an essay on Johann Kepler by W. Pauli, is about to be offered in the Bollingen Series in English. Though Jung does not regard this treatise as in any way a final proof of his views, but simply a conclusion from empirical premises, yet he does present a working hypothesis to explain natural phenomena falling outside of the causality gamut in our statistical science. He states that the synchronicity of events as observed by human beings demands a different principle of explanation.

Synchronicity is here defined as the coincidence in time of two or more causally unrelated events which have the same or a similar content. This is in contrast to synchronism, which simply means the simultaneous occurrence of two events. These can take three forms:

(a) "The coincidence of a certain psychic content with a corresponding objective process which is perceived to take place simultaneously."

(b) "The coincidence of a subjective psychic state with a phantasm (dream or vision) which later turns out to be a more or less faithful reflection of a 'synchronistic,' objective event that took place more or less simultaneously, but at a distance."

(c) "The same, except that the event perceived takes place in the future and is represented in the present only by a phantasm that corresponds to it."

It is important to note that it is not only the stress of the physical movement, namely the time coincidence, (where, by the way, a future as well as past incident may be coincident with a present one) but especially the stressing of the psychological aspect. It is solely the sense content which makes acausal events into unified experiences. Synchronicity is therefore only a formal factor, an empirical idea. It joins as a fourth function the recognized triad of space, time, and causality. Jung arrives in this way at a four-fold conceptual scheme of world events which should serve as a basis for comprehensive understanding of the totality of human experience.

Space

Synchronicity — Causality

Time

Seeking to reconcile this view with data derived from modern quantum mechanics, Jung offers the following elaboration of his diagram:

Indestructible energy

Inconstant connection based on meaningful relationships, synchronicity, or so-called "contingency" — Constant connection owing to the operation of causality

Time-Space Continuum

From the psychology of Jung and his archetypal world it is an easy transition to the acceptance of this fourth dimension. Thus we have an unconscious image coming into consciousness in the form of a dream, an idea or a premonition which then coincides in content with an objective situation. Most human beings have had such experiences, which up to now had to be accepted only as coincidence. But Jung does not stop with these intuitive or "mantic" examples. He enlarges upon several data such as the Rhine experiments and astrological studies. He uses again the example of the *I Ching*, whose value is based on the intuitive technique for grasping the whole, which is so characteristic of China. In all of it he brings out the philosophical and psychological aspects as well as the relation to modern developments in physics. He shows the decisive roll of the emotion-producing archetype for all the personal experiences of synchronicity. Thus the spiritual as well as physical aspect of the archetype becomes manifest. The causeless coinciding sensory events correspond in the last instance to a continuous creative principle. With the quaternity of causality, space, time and synchronicity, there is presented a bridge that connects scientific and religious thinking.

Pauli, in approaching the subject from the standpoint of the modern physicist, uses, curiously enough, the work of Kepler and Fludd in a religious and psychological sense. By postulating a cosmos, an order outside of control, the perceiver and the perceived come under this order. Pauli sees the archetypes as operators (traffic managers) in this cosmic order. He goes on to prove with material from Kepler and Fludd that these archetypes are the necessary postulates for the creation of a system of ideas in natural science. Through Kepler's exposition he throws light

on the psychological background of the seventeenth century, which marks the beginning of the emergence of the new scientific thinking from its animistic heritage. With natural scientists like Kepler and Fludd their psychological perceptions were clothed in religious creed. Pauli succeeds in seeing behind the explanations of Kepler a passable bridge between physical and psychic, which to him are complementary aspects of the same reality; that is, micro-physics on the one side and psychological unconscious on the other. Kepler devoted his life to the idea that knowledge is not derived from experience only, but it is necessary to compare what the mind has conceived with what the mind has observed.

The original images of the soul Kepler called "archetypical." Using the religious language of his day they are ideas, preexistent in the mind of God and implanted into the human soul. He believed that each stratum of reality is the image of a higher stratum. Things have a hidden meaning expressed by their external form. Thus the point would represent the human soul as the image of the sphere, which in turn would represent God. He thus came to regard the sun and planetary orbits as images of a higher meaning. Out of these he began his search for natural laws.

This was his approach to astronomy and astrology. Contradicting the regular astrologers such as Fludd, he denied a direct influence of stellar constellations on the human mind. He believed, however, that influences occurred if and when the angles in which stars could be observed had simple numerical relationships comparable to those of musical chords. This brought him in direct opposition to Fludd, who emphasized direct influence of the stars, and to others who denied any effects of stellar constellations. Because of his opposition to the two schools he called his book *Tertius Intervendus.*

In both Jung's and Pauli's treatments of this subject there is reference to the interrelation of triad and tetrad, known also as the three to four relationship. Here we have number as an archetype of order which has become conscious. In primitive patterns of order one sees mostly triads or tetrads. Psychic pictures of wholeness spontaneously produced by the unconscious are, as a rule, quaternities or their multiples expressing and creating order. The unconscious psyche finds itself in a space-time continuum in which space is no longer space, nor time, time. Thus, in the concept of synchronicity we have an approach to the understanding of cosmic order as well as an enlarging concept of the spirit as it manifests itself in nature.

— *Martha Jaeger*

The Mind and the Eye: Biology and Philosophy

The Mind and the Eye by Agnes Arber (Cambridge University Press, Cambridge, 1954, $3.00, 146 pp., index) is a scholarly and yet thoroughly delightful book on biological methods and philosophy. This distinguished British botanist divided the book in two parts, the first of which considers the nature of biological research and the second, the bases of biological thinking. The major topics are: asking the question, getting the facts to answer it, interpretation of the facts, testing the validity of the solution, the communication of the work to fellow-students, and (this occupies the last half of the book) standing back to see the work in perspective in order to make generalizations and to evaluate the results objectively.

"Since the first step in biological research involves the decision as to the question on which to concentrate, the researcher is at once put upon his mettle, for the full recognition and appreciation of a problem may task him even more severely than its solution . . . In practice, however, the paradox, that the thinker needs to have reached the end before he can make an effective beginning, must be ignored; for preparedness for the start never comes until the time for the starting has long gone by. So the biologist must begin without tarrying for full equipment, making shift from the first to pose his own question as best he may."

Mrs. Arber explains that no biologist can do his best work unless the scale of his problem is duly proportioned to the height of his powers and the width of his vision. ". . . When, however, a researcher, who might have been happily and usefully employed on a minor undertaking of this kind, tries to struggle with a major problem which dwarfs him, such powers as he can claim are paralyzed, and he is prevented from doing the service to science that in him lies; or else his reaction takes the form of whittling and paring down the subject, until he can bring it within his competence by rejecting its essential difficulties. He then congratulates himself on the facile conquest of his problem, forgetting that he induced it to disarm before he tried to overcome it. Indeed, the best of which a man is capable can be achieved only when his powers, and the theme on which he exercises them, are fitted to one another without discrepancy. This happy consummation may be attained only after a long and exacting process of trial and error.

"Problem choice is only a minor part of a wider intellectual discipline — the art of rejection.

"The value of continually advancing technique is inestimable, so long as it is not allowed to become an end in itself, and thus to foster delusive industry of a pointless kind."

For convenience in handling, the author referred to the researcher's problem as if it could be considered in isolation; but in doing so, she admitted that she has oversimplified the issue. "There is no such thing as *a* problem, just as there is no such thing as *a* fact or *a* thought. The questions which the biologist puts to Nature are integral parts of that living reticulum which is the intellectual life of the time; they cannot be seen truly except on the background of that reticulum, from which their vitality is drawn."

This should give the reader a fair sample of the author's style and treatment of the subject. "The development of scientific truth is . . . like an organism; it does not grow by accretion of ready-made parts, as a building does. In passing from phase to phase, it suffers transformations from within, like an animal proceeding from the embryonic stage to maturity. No conclusions in science can be immortal — they serve their season, and, if they survive at all, it is in the form of offspring theories, in which certain of their characters live again in a new guise."

Mrs. Arber has used extreme care to see that all the ideas are credited to the proper authors, and, therefore, the book combines the stimulation of a well-organized and presented philosophy of biology with the valuable references for the more diligent student. We cannot recommend the book too highly.

— *Ruth Lofgren*

Man's Unconquerable Mind and the Limits of Knowledge

Amid the alarms, confusions, and frustrations of the present day it is possible to detect a growing concentration upon the question, "What is man?" While there are Jeremiahs who foresee our doom, there are other voices raised which indicate that there may yet be hope in the uniqueness and resources of man. High on the list of such voices should be that of Gilbert Highet, whose book, *Man's Unconquerable Mind,* (Columbia University Press, N. Y., 1954, 128 pp., notes, $2.75) is a brilliant essay on the Columbia University theme: "Man's right to knowledge and the free use thereof."

Quoting a chorus from Sophocles' *Antigone,* "Wonders are many, but none,/none is more wondrous than man," Dr. Highet points out that, instead of singing a hymn to destiny or providence, ". . . it praises the thinking mind — which, together with a myriad other activities, contains the will; and which can transcend destiny not only through defying it but through understanding it. [Men] . . . marvel at that inexhaustible miracle, the human mind . . . And, as they read, they are once more aware of the meaning of the tragedy: which is that men and women think; that the lowest misery is slavery, not of the body, but of thought; and that even when our life is harsh and inexplicable, we may still make it into a worthy and heroic destiny, provided we maintain the invincibility of the mind."

After tracing the evolution of man, the author confronts those who predict that the next war will mean "the end of civilization." "It may well be the end of an era of civilization," he agrees but adds, "But as long as the planet is livable and as long as we possess, unimpaired, this fifty-ounce organ of exploration and invention and adaptation, the brain, we shall not only be able to reconstruct civilization. We shall be compelled to reconstruct civilization." Coming down to the present, he reminds us that ". . . the history of much of the twentieth century, with its struggles against communism and fascism and national socialism, and so on, will best be written as the record of a war for the command of men's minds."

Marvelling over the unpredictability of the mind (one never knows when or where a great mind may emerge and no one can tell when or into whose mind a new, high thought will occur), the author makes some pungent, yet beautifully-expressed, points about education. One should give students challenge and stimulus and "make things difficult for them . . . It is not enough . . . for a clever boy or girl to meet his fellows and his teachers and his parents . . . he (or she) must meet the immortals . . . the best way toward greatness is to mix with the great." Here is what sounds like a plea for integrated education with the full flavor and power of one's whole cultural heritage.

Exploring the future of knowledge, the author analyzes three possibilities: expansion, self-destruction, and thought control. Of the first, Dr. Highet is optimistic. Of the second he says that "most people respect knowledge, but they do not necessarily like it." We do not need a hydrogen bomb to commit suicide. We can do it effectively by organized silliness, by debauchery, by stupidity, pleasure, and riches. Regarding the possibility of thought control, he demonstrates that ". . . it is easy . . . to silence all questioning of established systems of belief and to regard critics as heretics, heretics as damned criminals . . . Our present age of adventure, disorder, and revolution may well be followed by an era of rigid orthodoxy . . . [in which men] enjoy the tame familiar process of solving the problems of their own brave new world, smaller but safer, meaner but tidier, than the vast incomprehensible universe."

Beautifully and sharply focussed is the section of the essay in which the author discusses the limitations of knowledge — both the limitations imposed by ourselves and those inherent in the structure of the mind and its relation to the universe.

Finally, in a "dedication," our author returns to the problems of education for all the people and the place of our colleges and universities in the human scheme of things. "Freedom of knowledge, like other freedoms, rests on many different pillars and is unsafe on one or two alone. Thinking is everyone's business."

— *Harvey W. Culp*

A Handbook for Criteria for Judging Schools

As a handbook for critics of education and schools, William F. Russell, President of Teachers College, Columbia University, has just written a small book, *How to Judge a School* (Harper and Brothers, N. Y., 1954, 138 pp., index, $2.50).

It is a readable, well-written book, the first part of which outlines older types of education and includes a chapter entitled, "Why an American Design for Education?" On the basis that "the ideal of our country is *Novus ordo seclorem,* a new order of the ages . . .," primitive, old Chinese, pre-1914 German, and Ottoman Empire types of education are all classified as "un-American." All of these were systems of education which fitted the ideals and supported the ways of life of their cultures.

Referring to the history of the founding of this country and to its fundamental documents, the author gives in capsule form one of the best analyses of what it is we are (or should be) aiming to do under the banner of "Americanism." But Dr. Russell's definition does not, as so many others do, lead him to view our "new order" out of its cultural context and with disregard for the long history from which it springs.

"How to judge a school" is, according to the author, a matter of considering (a) the product — what do we wish the schools to turn out? (b) the raw material — what is the nature of the child? (c) the process — how

best can the child learn and what is the nature of the means by which he can be most effectively taught? In analyzing these factors, we are given the truth about our former misconceptions (and they still persist surprisingly) about the transfer of training. Here "the good old-fashioned methods" which depended upon these misconceptions are shown to be both inadequate and inefficient. Eight popular misconceptions regarding the learning process are discussed as a preamble to an analysis of methods of teaching the basic skills — or the "three R's."

"Citizenship education" is on the lips of most of the present critics of our schools. But there is appallingly massive evidence on every hand that courses in civics and government plus pledges of allegiance to the flag are not enough. Here the author turns the tables on the critics by concluding: ". . . Education for citizenship is too serious a matter to leave to the teachers . . . Citizens have greater obligations than mere criticism of schools or paying taxes. About half the job of education for citizenship belongs to them."

This is an important and timely little handbook. Its purpose and philosophy is summed up in its concluding paragraph: "When the American people have more knowledge of the purposes, processes, and place of education in our society, when they appreciate the interlocking role of school, home, church, and other institutions, then they can see their local school problems in a larger perspective, and reach judgments that rise above tradition and prejudice. In the long run, the preservation of our liberty and the securing of our happiness and safety depend in large part on how we educate our children. Under the American plan the people hold control, and that is why it is important to learn how to judge a school."

— Harvey W. Culp

The Biological Basis of Individual Liberty

The myth of "the average man" is most effectively exposed by Dr. Roger J. Williams in *Free and Unequal* (University of Texas Press, Austin, 1953, $3.50, 177 pp., index). The author presents a wide variety of impressive biological evidence that there are more inborn differences among people, and that the biological basis of individual liberty — the real reason why freedom is an imperative need for all mankind — lies in the extent and character of these differences.

Dr. Williams warns that we have been giving lip-service to equality and then behaving as if we meant uniformity instead. Merely changing the environment does not change a person's basic nature. Actually, of course, the question is not heredity versus environment because these factors always work together.

"As a result of this tendency toward environmentally-centered thinking and investigation, the doctrine of the essential uniformity of human infants has been widely accepted and is held by a great body of social psychologists, sociologists, social anthropologists, and many others, including historians, economists, educationalists, legal scholars, and men in public life. The doctrine has been incorporated into the prevailing mode of thought of many who have to do with shaping educational and governmental policies and is often accepted unquestioningly by those who do little critical thinking of their own."

It seems clear to Dr. Williams that the idea of freedom arose directly out of human variability. "If we were all alike there would seem to be no reason for wanting freedom; 'living my own life' would be an empty, meaningless expression. True, we are alike as human beings, and have a common role to play in the world, but among the infinite number of ways to play the role we crave the liberty of our own choices."

"Biology, with variability as its cornerstone, confers on every human individual a unique set of attributes which gives him a dignity which he could not otherwise possess. Every newborn baby is an unknown quantity so far as potentialities are concerned because there are many thousands of unknown interrelated genes and gene patterns which contribute to his makeup . . . In every case he or she has the making of a distinctive individual . . . Failure to achieve success in one type of activity need not destroy morale. We will be healthier mentally if we recognize that each of us has his natural limitations. Healthy striving can be fostered by the knowledge that our distinctive potentialities are never exhausted."

The author gives specific evidence to show that our signatures, nutritional requirements, intellectual and emotional patterns, personal likes and dislikes have a strong hereditary basis. "It is an unfortunate fact that people in general — 'educated' or not — are ignorant about the diversity of tastes. This permits them to be dogmatic and certain about the validity of their own. These observations apply not only to tastes in the narrower sense . . . but also to the tastes in literature, music, art, etc."

Dr. Williams points out that there are inherent differences in abilities to learn specific subject matter. A person may be very slow in one field and brilliant in another. This should help us to develop more realistic goals and more suitable methods for educating "individuals."

There are decided differences in what different people want. "Our success in the whole field of human relations depends to a very great extent upon our understanding the want patterns of the individuals who make up society . . ."

Dr. Williams describes interesting tests that he devised to demonstrate marked individual differences in terms of physiological and nutritional functioning and many of the more subjective wants. The results of these tests clearly indicate the tremendous variations among people of similar backgrounds and training.

". . . I dare to hope that on the basis of careful examination, the uniformity idea with all of its connotations will gradually become discredited and discarded and that the ultimate acceptance of the non-uniformity idea will greatly strengthen our love of liberty and foster wholesome human relations. If this hope is realized, we will be able to perform further wonders by environmental control, and will be pioneering toward the development of a science of human understanding. Only in this way can we insure that 'government of the people, by the people, and for the people shall not perish from the earth.' "

— Ruth Lofgren

NEWS AND NOTES

1954 Summer Workshop at Wisconsin State College

The program of the 1954 workshop is addressed specifically to the acute concern which state colleges, and other teachers' colleges and departments of education, now so properly have about the increasing disintegration of knowledge, caused by specialization.

The workshop dates are fixed from the afternoon of Monday, July 19th, through noon, Friday, July 23rd, 1954.

By kind invitation of Wisconsin State College, Milwaukee, the participants and the activities will be housed in Kenwood Hall, on the shore of Lake Michigan.

The theme of the workshop will be developed in terms of four aspects in education:

1. *A Basic Methodology for Integration*

HENRY MARGENAU

We confront today a situation which is at once a problem and a promise. Technological science constitutes a new force. Education has served engineering and industry, and thus also society, by disseminating literacy and other skills we have required. But the true spirit and method and the real meaning of science, as basic ingredients of philosophy, have not been communicated with comparable effectiveness. It is a consequence of this educational imbalance that technological changes in society have been accelerated, but philosophic, cultural, adjustment has lagged.

It is unreasonable to believe that balance can be restored to knowledge, or that a firm philosophy can be taught, if the meaningful role of science in culture is neglected. The following question, therefore, calls for an answer:

> "What is the essential character of the methodology and conclusions of modern science, which must be taught and employed in order to use the philosophical resources of science to re-unite knowledge and thus to restore wholeness and wholesomeness to life?"

Following this talk will be a discussion on "Basic Concepts in Physics and Chemistry Related to Integrative Teaching," led by Vernon Bollman of Occidental College.

2. *General System Theory: Its Role in Scientific and Educational Integration*

LUDWIG VON BERTALANFFY

While modern science is characterized by continually increasing specialization, striking correspondences of general principles and constructs are apparent in the various branches of natural and social science. They are the more significant since the developments in the individual fields were mutually independent and largely unaware of each other. This necessitates a new basic and general discipline, aiming at establishing those principles which are common to, and thus applicable in various sciences, from physics to biology to psychology and the social sciences. This field is called General System Theory. The program of General System Theory is outlined and illustrated by examples. It is shown how it applies in establishing theoretical models and laws in fields outside of physics, in the scientific formulation of seemingly teleological but necessary concepts, in justifying the unity of science.

This has an important bearing on integrated education. Conventional education in physics, biology, psychology, and the social sciences means training in isolated domains, the general trend being to make increasingly smaller sub-domains into separate units. In contrast, the structural correspondence of constructs and laws in different fields offers integrative principles, bridging, in particular, the gap between the natural and social sciences. A program along the lines indicated is presented.

Following Prof. von Bertalanffy's talk, there will be a discussion on "Basic Concepts in Biology Related to Integrative Teaching," led by Ruth Lofgren, Research Associate of the Foundation for Integrated Education, and J. D. Hamilton, University of Western Ontario Medical School.

3. *The Knowing Mind in the Orderly Universe*

HARVEY W. CULP

Learning is admittedly a complex process. In learning language, for instance, first a child makes natural cries, then speaks words in imitation of others, and subsequently speaks sentences. Only after years of experience in doing this does he begin to understand grammatical structures in conscious conceptual form. The natural sequence of learning other than the more simple activities seems to be doing, imitating, specific effort, reflection, and finally consciously conceptualizing from

experience. This latter is exclusively a human function.

The same sequence in learning occurs with other arts and skills. Structural and mechanical skills developed long before the laws of physics were formulated. Music and visual arts developed before the laws of harmony and of aesthetic measure were discovered. However, it is always the conceptual understanding of the underlying structure which enables man to integrate the diverse reports of his senses into understandable and emotionally satisfying wholes, and thus to make his greatest strides in dealing with his environment.

It follows that the conceptualizing process may best be emphasized at the place in which it naturally enters the learning sequence. Conscious reflection can be made an exciting interest when introduced not too early or in an unnatural order.

Education more commonly attends to the conscious and logical end products of the knowing process to the neglect of unconscious or nonrational functioning and the concept-constructing process. We tend to focus on empirical and classified knowledge with insufficient emphasis on how it was obtained—the mental faculty of conceptualizing whereby the empirical and experiential are given form, meaning, and generalized application. In this way both teacher and student are in peril of falling into the error of believing that the mind *legislates* rather than, by its own inner ordering, *discovers* natural law.

Teachers often come to feel that the mind resists learning. Students sometimes develop a sense of harassed inferiority in the face of what is apparent arbitrary unrelatedness. Both would be freed to achieve greater results in the process of education were they to become conscious continually that the mind dynamically seeks the experience of relationship and pattern from which to construct abstract and symbolic meaning. Furthermore, these abstract and symbolic meanings, these concepts by which the human mind grasps the natural orders of the universe, are the central purpose of education. Only as we grasp the wholeness of a situation are we well able to deal with it. Accurate integrative concepts, which conform to the interrelated processes of nature, are then able to generate suitable applications for specific problems.

If education for our times is to be broadened, deepened, and integrated, a question is raised:

> "What potentialities for more effective and more meaningful teaching are inherent in fostering awareness of the central position of the human mind and of the processes of knowing?"

This talk will be followed by a discussion of "Basic Concepts in Psychology and the Social Sciences Related to Integrative Teaching, Including Curriculum Rebalancing." A. A. Suppan, Wisconsin State College, will preside, with Thomas C. Schuller, Scarborough School, Morris I. Stein, University of Chicago, and Mr. Culp participating.

4. *Applications to the World Scene*

F. L. Kunz

Throughout human history all men have mobilized their concepts from every available source to arrive at their hypotheses as to the constitution of man, the nature of the universe, and the meaning of life. This process has been nurtured and evolved in the arts, sciences, sports, religions, philosophies, and in ethical, social, and political norms. Every culture has, by this means, arrived at conclusions and insights of life value. Thus every culture has a contribution to make to the whole.

All cultures except our own have integrated their science with the rest of their culture. Only in our own recent past have science and the rest of our culture been divorced. Gradual use of the means at hand for a restoration of balance and unity between the sciences and the humanities should assist our own culture to be so reintegrated as to afford a means of rapprochement between ours and other cultures.

Broadly, two great groups of cultures have emerged—the East and the West. For the achievement of a settled world in the future, new attitudes must be developed and education must take account of these circumstances. Hence the query:

> "What is likely to be the result of an education which reincorporates science into the cultural experience, in bringing about world understanding, the meeting of the East and the West?"

Following the talk, there will be a general discussion of the teaching aspects of this subject, led by Mr. Kunz.

Each evening will be devoted to one of the four aspects by the resource person designated. The discussion to follow immediately will be restricted chiefly to clearing up any possible obscure points in the discourse.

The following morning will be devoted to the discussion of the actual educational adjustments implied, especially the changes called for in secondary schools and colleges.

Registration

A limit has necessarily to be placed upon registration. This will be determined by the quarters assigned by the College, and by the need to keep the number within manageable limits for purposes of discussion.

An effort will be made to accommodate laymen whose professions make the conference of special interest.

The fee for the entire program (including board and lodging) is $45 and there is no addi-

tional charge. For those who have board and lodging elsewhere, the fee is $25. To permit of family residence, the maintenance charge (room and meals) for a wife or child is fixed at $25.

Reservations, by mail, may be addressed up to July 15th to the Foundation for Integrated Education, 246 East 46th Street, New York 17, N. Y. (Telephone: MUrray Hill 2-5672). After that send to Dr. Adolph A. Suppan, Director, Extension and Summer Sessions, Wisconsin State College, Milwaukee.

Registrations should be accompanied by a deposit of $10 per person.

Arrivals, registration, and room assignment will be from 1 p. m. onward, Monday, July 19th, in Kenwood Hall, Wisconsin State College, Milwaukee. Dinner will follow at 6 p.m. (informal) in the dining room assigned to the workshop. The program will begin at 7:30 p.m.

An outstanding exhibit on "Biology and Human Progress" opened at Sarah Lawrence College on World Health Day, April 7th. The biology class, under the direction of Dr. Madeleine P. Grant (see book review section, *Main Currents in Modern Thought,* Vol. 10, No. 1, p. 19.) had prepared colorful world maps showing the measurement of health in various parts of the world, the work of the World Health Organization in providing help for mothers and children, in the fight against malaria, tuberculosis, poliomyelitis, and venereal disease. There were excellent photographs showing the kinds of work that the World Health Organization and the Food and Agriculture Organization are doing to improve the health of people all over the world.

A group of faculty members of Eastern Nazarene College, meeting to inquire into many phases of the interpretation of religion as illuminated by the findings of science, has now begun the issuance of a bi-monthly *Newsletter on Religious Inquiry.* Each issue will carry reviews of books and other literature, reports of lectures and conferences attended, open letters of inquiry, and news items of interest.

The first issue states the objectives of the fellowship: (1) Fearless seeking for the truth, (2) Putting religion in terms intelligible to modern minds, and (3) Stimulating and satisfying the human need for spiritual and intellectual fellowship. There is no charge for the *Newsletter,* which may be received by application to J. H. Shrader, 30 Copley Street, Wollaston 70, Mass.

"Aging—Everybody's Business" is the title of the University of Michigan's seventh annual Conference on Aging to be conducted as a workshop in Ann Arbor, Michigan, June 28-30, 1954.

The workshop will provide participants with the opportunity to exchange ideas with persons of varied experience and to establish bench-marks for the creation of an environment in which the senior citizen can enjoy life-long development.

Leaders in health, business, employment, labor, education, rehabilitation, social work, religion, housing, recreation, community organization, city planning, and government are invited to attend, as are members and officials of fraternal organizations, women's clubs, service organizations, retirement groups, and voluntary organizations. Older people are especially invited.

For further information, write to Dr. Wilma Donahue, Chairman, Division of Gerontology, 1510 Rackham Building, Ann Arbor, Michigan.

"Religion in the Age of Science" is the subject of the fifth annual Interfaith Conference on the Coming Great Church, to be held July 31-August 7 on Star Island, off Portsmouth, N. H. Speakers will include Karl W. Deutsch, Edwin P. Booth, C. J. Ducasse, Philipp Frank, Edwin C. Kemble, Gerald Holton, Henry Margenau, Harlow Shapley, George Wald, Roy G. Hoskins, H. B. Phillips, and B. F. Skinner.

The conference will offer the opportunity both to hear religious thinkers concerned with the problem of restating religious doctrines for today, and to hear scientists presenting their thinking in three areas of concern to religion: (1) the nature of truth and reality, (2) the nature of the cosmos, and (3) the nature of man. The conference will seek to integrate scientific and religious thinking.

For further information on the conference, contact The Star Island Corporation, 355 Boylston St., Boston 16, Mass.

Findings which indicate that "the weakness of the reality contact is related to the general level of maladjustment" are described in an article, "Objective Measurement of Reality-Contact Weakness" by Albert Kreinheder, (*Psychological Monographs,* Vol. 66, No. 343, 1952). The author finds that processes of thinking are conspicuously influenced by one's realistic or unrealistic attitude toward the surrounding world. The conclusion has less significance in regard to specific conditions which vary from individual to individual than in regard to reality in general. The collected evidence of the study supports the idea that "a concept of general reality contact has practical usefulness even though it be abstracted from specific instances."

— *Ralph B. Winn*

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